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Mitosis in living cells

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Practically all of the work done on the phenomena of cell division has been done with material that has been fixed, imbedded in paraffin, sectioned, and finally stained; this method has been subjected to various criticisms and it has been maintained that figures observed in the fixed and stained cells are artifacts, stages that do not exist in nature. Although these criticisms have been squarely met in many cases, undoubtedly much valuable data might be obtained by devoting more time to the study of the living cell.

Very favorable material for studying cells in the living condition has been found in the young anthers of some of the maples. Twigs of the red maple, *Acer rubrum*, with flower buds were gathered on February 10 before any swelling of the buds had taken place. Twigs about 6–10 inches long were brought into the laboratory, placed in a glass of water and kept near the window, the water was changed every day or two and the base of the stem often cut afresh. To examine the pollen mother cells the bud scales were removed and the young flowers placed on a slide and mounted in water; if the anthers are long enough it is best to cut them crosswise with a sharp knife; by pressing down on the cover glass the mass of spore mother cells are forced out of the anther and are then readily observed. In the case of the red maple the mother cells began to divide on February 17, one week from the time they were picked from the tree, whereas those left on the tree did not divide until one week later; the advantage of bringing them into the laboratory is that one may examine them every day and so determine in what stage of growth or division the cells may be. I was able to observe the chromosomes in the equatorial plate, and in polar view was able to count as many as 40, fixed and stained material showing practically the same number. An advantage in the living cell at this stage is that the chromosomes are placed about equally distant from each other and not drawn close together as is often the case when fixed and stained. The spindle was clearly marked and the spindle fibers distinguishable; anaphase and telophase stages could be readily observed; in fact practically all of the division figures to be found in fixed and stained material were observed in these living cells. The spireme is rather thin in this form, so that it could not be detected in the living cell; the nucleolus with a budlike attachment was plainly seen. The cytoplasm in *Acer rubrum* is not so dense as to obstruct or confuse the view of the nucleus as it is in some forms.

Various stages in the division of the daughter nuclei were as clearly seen as were those of the mother cell; these daughter nuclei divide very soon after the first division of the mother cell, without the formation of the new cell wall. Within twenty-four hours after the first cells were seen to have begun division practically all of the mother cells in the material had formed the four distinct spores, showing that these stages go on rapidly.

Attempts were made to induce the cells to complete their divisions by placing them in sugar solutions of various strengths from 2 per cent to 15 per cent, but in no case did a cell continue to divide after being forced out of the anther.

Twigs of the silver maple, *Acer saccharinum*, were brought into the laboratory on the same dates as those of the red maple; although the cytoplasm is denser and although the division figures were not so clearly marked, yet practically all of the stages observed in the red maple were seen in the pollen mother cells of this species. In the Norway maple, *Acer platanoides*, the division of the pollen mother cells takes place much later in the season. On March 20 twigs were brought into the laboratory, and on March 23 the mother cells divided. Various division figures were observed in this species together with a very conspicuous budlike process on the large nucleolus. The cytoplasm in this species is more dense and more granular than that in *Acer rubrum*, so that the chromosomes and spindle fibers were not so clearly seen. The mass of spore mother cells does not force out of the anther until the cells are nearly ready to divide, usually within a day or two, whereas in the red maple the tapetal cells become detached from the endothecium of the anther at least two weeks before division.

In the European larch, *Larix decidua*, I have observed the pollen mother cells in stages of division, although the presence of numerous starch grains and of granules in the cytoplasm often obscures the definiteness of the figures.

Because of the simplicity of the means any one interested in seeing the chromosomes, nucleoli, and stages in the division of the living cell may do so with an ordinary compound microscope with a 1/6 in. objective. The only difficulties that may arise are: to obtain the flower buds before division of the pollen mother cells has taken place, which may be four weeks or more before the flowers open, as was the case in the maples this year; the other difficulty may be in the density of the cytoplasm, but this varies with different species and with different anthers of the same species.

These few observations are recorded to emphasize the fact that many of the phenomena presented in fixed and stained material can easily be verified as existing in the living cell.

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